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Stata tip 15: Function graphs on the fly

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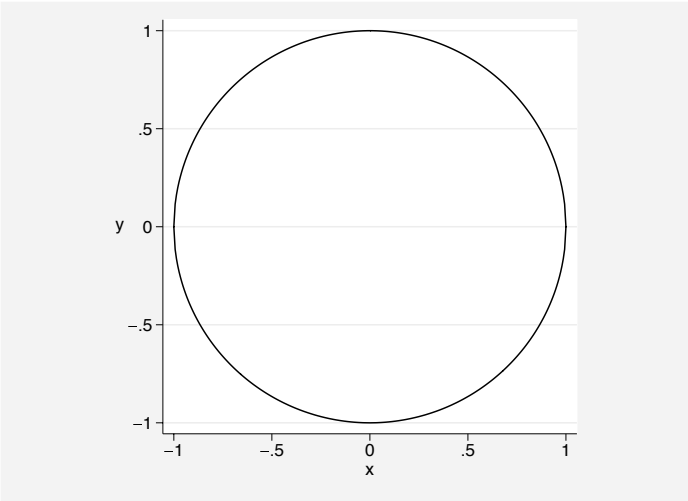
[G] **graph twoway function** gives several examples of how function graphs may be drawn on the fly. The manual entry does not quite explain the full flexibility and versatility of the command. Here is a further advertisement on its behalf. To underline a key feature: you do not need to create variables following particular functions. The command handles all of that for you. We will look at two more examples.

A common simple need is to draw a circle. A trick with `twoway function` is to draw two half-circles, upper and lower, and combine them. If you are working in some scheme using color, you will usually also want to ensure that the two halves are shown in the same color. The `aspect()` option was explained in Cox (2004).

```
. twoway function sqrt(1 - x * x), ra(-1 1) ||
>        function -sqrt(1 - x * x), ra(-1 1) aspect(1)
>        legend(off) yla(, ang(h)) ytitle(, orient(horiz)) clp(solid)
```



MacKay (2003, 316) asserts that, if we transform beta distributions of variables P between 0 and 1 to the corresponding densities over logit $P = \ln[P/(1-P)]$, then we find always pleasant bell-shaped densities. In contrast, densities over P may have singularities at $P = 0$ and $P = 1$. This is the kind of textbook statement that should provoke some play with friendly statistical graphics software.

To explore MacKay's assertion, we need a standard result on changing variables (see, for example, Evans and Rosenthal 2004, theorems 2.6.2 and 2.6.3). Suppose that P is an absolutely continuous random variable with density function f_P, h is a function that is differentiable and monotone, and $X = h(P)$. The density function of X is then

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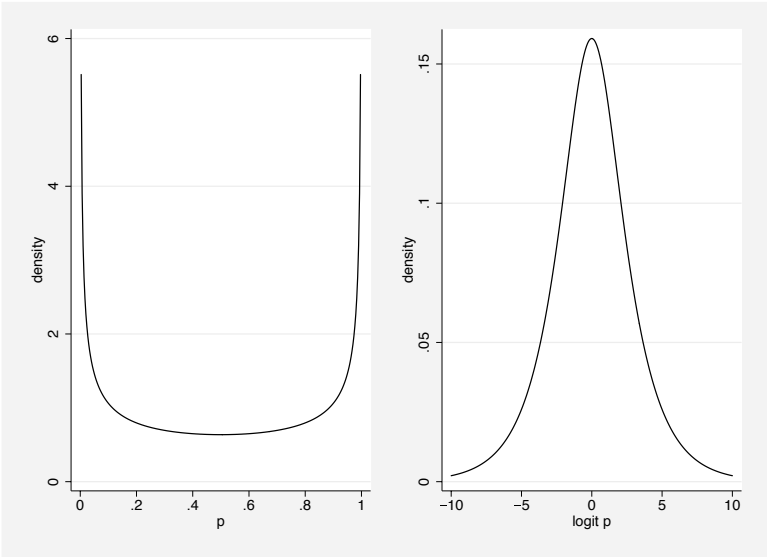
$$f_X(x) = \frac{f_P\{h^{-1}(x)\}}{|h'\{h^{-1}(x)\}|}$$

In our case, $h(P) = \text{logit } P$, so that $h^{-1}(X) = \exp(X)/\{1+\exp(X)\}$ and $h'\{h^{-1}(X)\} = \{1 + \exp(X)\}^2/\exp(X)$. In Stata terms, beta densities transformed to the logit scale are the product of `betaden(p)` or `betaden(invlogit(x))` and `exp(x)/(1+exp(x))^2`. The latter term may be recognized as a logistic density function, which always has a bell shape.

An example pair of original and transformed distributions is given by the commands below. To explore further in parameter space, you need only vary the parameters from 0.5 and 0.5 (and, if desired, to vary the range).

```
. twoway function betaden(0.5,0.5,x), ytitle(density) xtitle(p)
. twoway function betaden(0.5,0.5,invlogit(x)) * (exp(x) / (1 + exp(x))^2),
> ra(-10 10) ytitle(density) xtitle(logit p)
```



References

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Evans, M. J. and J. S. Rosenthal. 2004. *Probability and Statistics: The Science of Uncertainty*. New York: W. H. Freeman.

MacKay, D. J. C. 2003. *Information Theory, Inference, and Learning Algorithms*. Cambridge: Cambridge University Press. Also available at *http://www.inference.phy.cam.ac.uk/mackay/itprnn/book.html*.